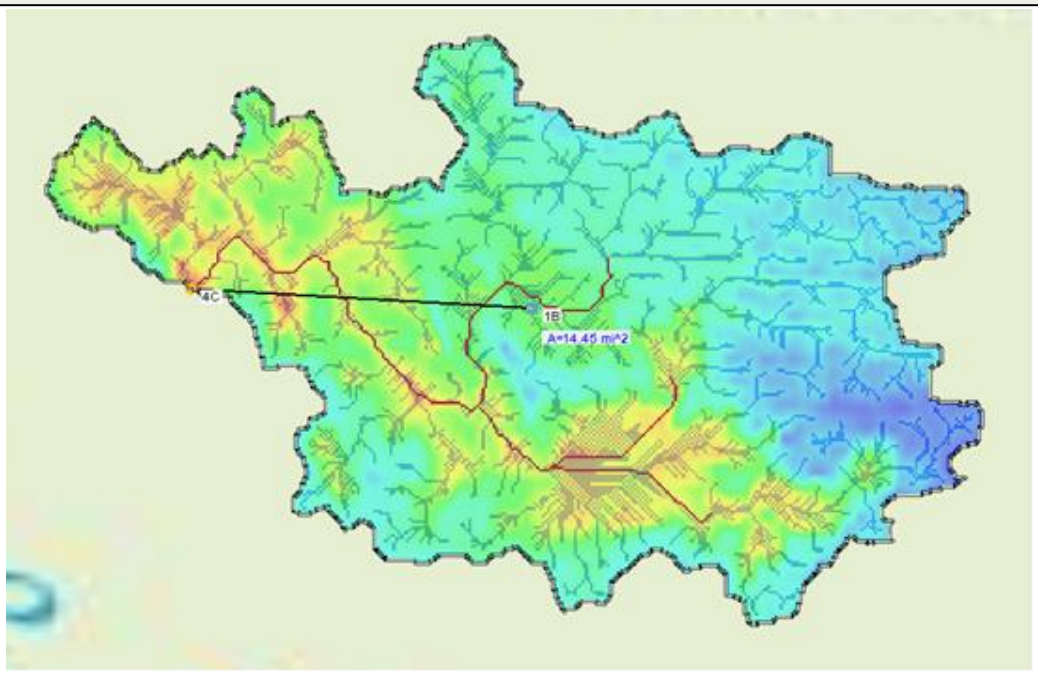
WMS 11.2 Tutorial

Orange County Unit Hydrograph

Build and run a unit hydrograph analysis based on methods in the Orange County (California) hydrology manual



Objectives

This tutorial shows how to define and run basic Orange County unit hydrograph models. Different options are explored for computing and routing hydrographs. This is based on the example problem on page E-26 of the Orange County Hydrology Manual.

Prerequisite Tutorials

- Introduction to WMS

Required Components

- WMS Core
- OC Hydrograph Model

Time

- 20–40 minutes

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1 Introduction

This tutorial will cover the steps necessary to create a unit hydrograph analysis based on the example problem on page E-26 of the Orange County Hydrology Manual.

2 Orange County Hydrology Manual Example

The first example will go over how to manually create an Orange County hydrology model.

2.1 Create Hydrologic Tree (Schematic) Model

Start with creating a hydrologic tree (schematic).

1. Open WMS. If WMS is already open, select *File* **| New** and click **No** if prompted to save changes.
2. Switch to the **Hydrologic Modeling Module**  .
3. Select *Tree* **|** *Add* **| Outlet** (or press the O key on the keyboard).
4. Select *Tree* **|** *Add* **| Basin** (or press the B key on the keyboard).

This generates a basic schematic model representing a concentration point with one sub-area.

5. Make sure that the *Model* dropdown is set to “OC Hydrograph”.

2.2 Enter Job Control Parameters

Now to define the model parameters for the model run:

1. Select *OC Hydrograph* **| Job Control…** to open the *HEC-1 Job Control* dialog.
2. For the *Computational time interval* enter "5".
3. Set the *Number of hydrograph ordinates* to "350".

NOTE: The number of unit hydrograph ordinates should be enough to cover the duration for the storm event at the computational time interval. For example, if the computational time interval entered is 1 minute, then the number of hydrograph ordinates for a 1-day storm event should be at least 1,440.

4. Select **OK** to close the *HEC-1 Job Control* dialog.

2.3 Define the Storm Event

Now to enter storm event parameters:

1. Select *OC Hydrograph* **| Define Storm…** to open the *Orange County Storm* dialog.
2. Change the *Frequency* to "100 year".
3. Select **OK** to close the *Orange County Storm* dialog.

2.4 Edit Sub-area Parameters

Parameters for the sub-area need to be defined.

1. Use the **Select Basin**  tool to select the sub-area labeled 1B.
2. Select *OC Hydrograph* **| Edit Parameters…** to open the *Edit Orange County Unit Hydrograph Parameters* dialog.
3. Click **Basin Data…** to open the *HEC-1 Basin Data* dialog.
4. Enter an *Area* of "5" sq. miles (3200 acres).
5. Turn on *Enter base flow*.
6. In the *STRTQ* field enter "-10" to represent a base flow of 10 cfs/sq. mile.
7. Select **OK** to close the *HEC-1 Basin Data* dialog.

2.5 Develop Effective Precipitation

Now to define precipitation parameters for the sub-area:

1. Click **Effective Precipitation…** to open the *Orange County Precipitation Wizard – Step 1 of 2* dialog.
2. Enter a *Fm* value of "0.19".
3. Enter a *Ybar* value of "0.337".
4. Click on the **Next** button to view the effective precipitation.
5. Click **Done** to close the *Orange County Precipitation Wizard* dialog.

2.6 Define the Unit Hydrograph

Now to enter unit hydrograph parameters:

1. Click **Unit Hydrograph Method…** to open the *Orange County Unit Hydrograph* dialog.
2. Enter a *Lag time* of “0.75”.
3. Under the *S-graphs* section, turn on the *Valley developed* option and enter “1.0”.
4. Click **Plot Unit Hydrograph** to view a plot of the hydrograph.
5. Select **OK** to close the *Orange County Unit Hydrograph* dialog.
6. Click the **Done** button on the *Edit Orange County Unit Hydrograph Parameters* dialog.

2.7 Running the Simulation

The model has now been defined and the simulation can now be launched.

1. Select *OC Hydrograph* **| Run Simulation…** to open the *HEC-1 Run Options* dialog.
2. Click the **browse** button next to *Input File* to open the *Select HEC-1 Input File* dialog.
3. For the *File name* enter “ochme-26” and click **Save** (this specifies the file name but does not actually save it).
4. Verify that the *Save file before run* option is turned on.
5. Select **OK** to launch the *Model Wrapper* dialog.
6. When HEC-1 finishes running, select **Close** to exit the *Model Wrapper* dialog.
7. Double-click either hydrograph icon (near the outlet or basin) to open a *Hydrograph* window.

The *Hydrograph* window allows viewing a plot of the average runoff hydrograph ordinates as shown in Figure 1. The hydrograph will draw a smooth curve in order to determine the peak discharge as outlined on page E-40 of the Orange County Hydrology Manual.

8. Click on the to close the *Hydrograph* window.

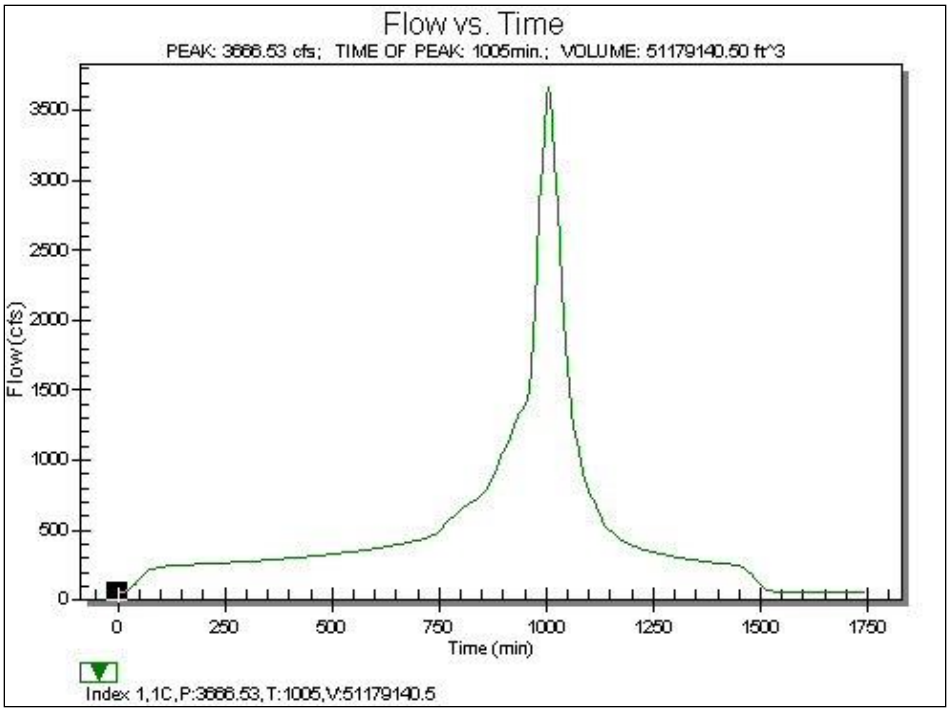

Figure 1 Runoff hydrograph

2.8 Saving Files

Now to save the HEC-1 model and to save a WMS project file for future use:

1. Select *OC Hydrograph* **| Save HEC-1 File…** to open a *Save* dialog.
2. Enter “OC-manual.hc1” for the *File name* and select **Save** to save a HEC-1 input file (*.hc1)

The HEC-1 input file contains all of the standard HEC-1 cards and parameters. It does not have any of the input parameters such as point precipitation values and S-graph data that are used to generate HEC-1 input.

3. Select *File* **| Save As** to open the *Save As* dialog.
4. Enter “OC-manual.wms” for the *File name* and select **Save** to save a WMS project file (*.wms).

The WMS project file stores all of the HEC-1 input data for each sub-area and concentration point as well as the data used to generate the HEC-1 input.

3 Flow-through Routing

Flow-through routing is also known as storage routing using the Modified-Puls method. This next example starts with opening a HEC-1 file that already has the inflow and job control parameters defined for the flow-through routing example on page F-9 of the Orange County Hydrology Manual. The routing parameters will be entered and, after running the simulation, the routed hydrograph will be viewed.

3.1 Open Unit Hydrograph File

Start with opening the project file.

1. Select *File* **| New** .
2. Select **Don't Save** if prompted to save changes to the project.
3. Switch to the **Hydrologic Modeling Module** . Make sure that "OC Hydrograph" is selected from the *Models* window.
4. Select *OC Hydrograph* **| Open HEC-1 File…** to bring up an *Open* dialog.
5. Locate the file "OCHMFlowThru.hc1" in the data files for this tutorial.
6. Click **Open** to import the project.

This is a simple model containing only an outlet and a basin.

3.2 Define Routing

Now to define the flow-through routing parameters before running the simulation:

1. Use the **Select outlet** tool to select the concentration point labeled 1C.
2. Select *OC Hydrograph* **| Edit Parameters…** to open the *Edit Orange County Unit Hydrograph Parameters* dialog.
3. Click **Routing Data…** to open the *HEC-1 Routing Data* dialog.
4. Change *Routing type* to "Storage (RS)".
5. Select *Reservoir* and click **Define** to open the *HEC-1 Reservoir Routing Options* dialog.
6. In the *Outflow* section of the dialog select *Known outflow*.
7. Turn on *SE* and click **Define** to open the *XY Series Editor.*
8. Enter the values in the *Elevation* column of Table 1.

Table 1: Elevation, storage, and discharge data

Elevation (SE)	Outflow (SQ)	Volume (SV)
0.0	0.0	0.0
1.0	4.2	14.4
2.0	12.0	28.8
3.0	51.7	43.2
4.0	114.7	57.6
5.0	186.8	72.0
6.0	263.2	86.4

9. Select the remaining cells in the column and hit the *Delete* key on the keyboard so that the cells are blank.
10. Select **OK** to close the *XY Series Editor*.
11. Turn on *SQ* and click **Define** to open the *XY Series Editor.*
12. Enter the values in the *Outflow* column of Table 1.
13. Select the remaining cells in the column and hit the *Delete* key on the keyboard so that the cells are blank.

14. Select **OK** to close the *XY Series Editor*.
15. In the *Volume* section of the dialog choose *Known volume*.
16. Turn on *SE* and click **Define** to open the *XY Series Editor.*
17. Change the *Selected curve* to “1C Outflow elev”.
18. Select **OK** to close the *XY Series Editor*.
19. Turn on *SV* and click **Define** to open the *XY Series Editor.*
20. Enter the values in the *Volume* column of Table 1.
21. Select the remaining cells in the column and hit the *Delete* key on the keyboard so that the cells are blank.
22. Select **OK** to close the *XY Series Editor*.
23. Select **OK** to close the *HEC-1 Reservoir Routing Options* dialog.
24. Select **OK** to close the *HEC-1 Routing Data* dialog.
25. Select **Done** to close the *Edit Orange County Unit Hydrograph Parameters* dialog.

3.3 Run the Simulation

Now to run the simulation:

1. Select *OC Hydrograph* **| Run Simulation…** to open the *HEC-1 Run Options* dialog.
2. Click the **browse** button next to *Input File* to open the *Select HEC-1 Input File* dialog.
3. For the *File name* enter “OCHMFlowThruRoute” and click **Save**.
4. Verify that the *Save file before run* option is turned on.
5. Select **OK** to open the *Model Wrapper* dialog.
6. When the simulation has finished running, select **Close** to exit the *Model Wrapper* dialog.
7. Select one of the two hydrograph icons displayed at the concentration point labeled 1C.
8. Hold the *Shift* key down and double-click on the other hydrograph icon to open the *Hydrograph* window.

Figure 2 shows the inflow and the routed outflow hydrographs.

9. Click on the to close the *Hydrograph* window.

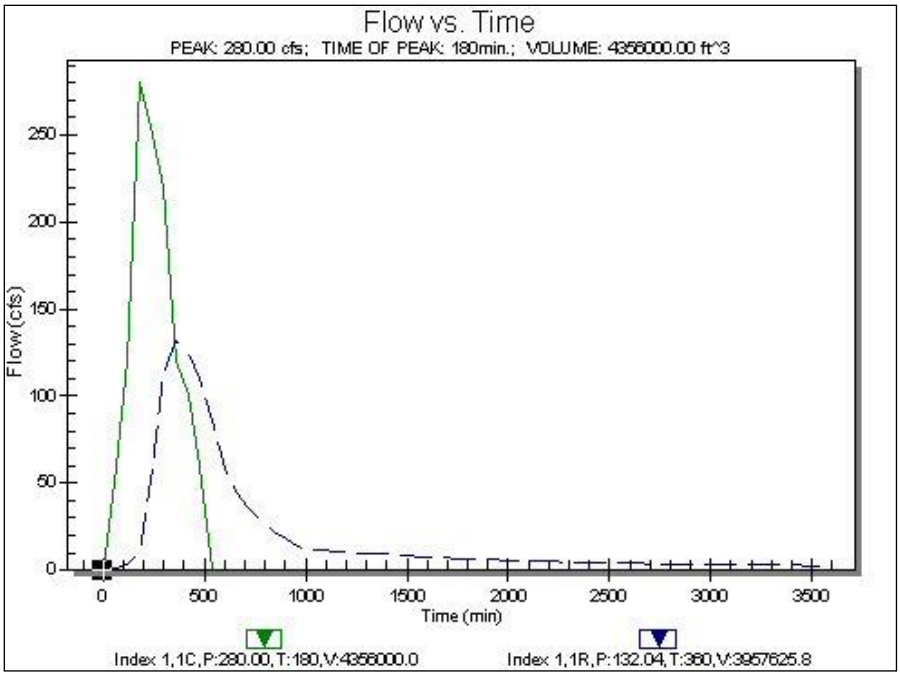

Figure 2 Inflow and routed outflow hydrographs for flow-through routing

4 Flow-by Routing

The next example makes use of flow-by routing.

4.1 Open Unit Hydrograph File

Start with opening a new project.

1. Select *File* **| New** .
2. Select **Don't Save** if prompted to save changes to the project.
3. Switch to the **Hydrologic Modeling Module** . Make sure that "OC Hydrograph" is selected from the *Models* window.
4. Select *OC Hydrograph* **| Open HEC-1 File…** to bring up an *Open* dialog.
5. Locate the file "OCFlowBy.hc1" in the data files for this tutorial.
6. Click **Open** to import the project.

This project contains two concentration points and two basins.

4.2 Define Routing (Constant Diverted Flow)

Now to define the flow-by routing parameters before running the simulation:

1. Use the **Select outlet** tool to select the concentration point labeled 1-14C.
2. Select *Tree* | *Add* | **Diversion**.
3. Use the **Select diversion** tool to select the diversion labeled D1.

4. Select *OC Hydrograph* | **Edit Parameters…** to open the *Edit Orange County Unit Hydrograph Parameters* dialog.
5. Click **Diversion Data…** to open the *HEC-1 Diversion Data* dialog.
6. To define the inflow portion of a rating curve for flow into concentration point 1-14C, select **Define DI** to open the *XY Series Editor*.
7. On the first row enter “0.0”.
8. On each succeeding row, increment the value by 100.0 so that the value on the last row is “1900.0”.
9. Select **OK** to close the *XY Series Editor*.
10. Define the diverted flow portion of the rating by clicking on **Define DQ** to open the *XY Series Editor*.
11. Enter a constant diverted flow of “50.0” in all rows.
12. Select **OK** to close the *XY Series Editor*.
13. Select **OK** to close the *HEC-1 Diversion Data* dialog.
14. Select **Done** to close the *Edit Orange County Unit Hydrograph Parameters* dialog.

4.3 Run the Simulation

Now to run the simulation:

1. Select *OC Hydrograph* **| Run Simulation…** to open the *HEC-1 Run Options* dialog.
2. Click the **browse** button next to *Input File* to open the *Select HEC-1 Input File* dialog.
3. For the *File name* enter “OCHMFlowByRoute” and click **Save**.
4. Verify that *Save file before run* is turned on.
5. Select **OK** to start the *Model Wrapper* dialog.
6. When the simulation has finished running, select **Close** to exit the *Model Wrapper* dialog.
7. Select the hydrograph icon displayed at the concentration point labeled 1-14C.
8. Hold the *Shift* key down and double-click on the hydrograph icon labeled 1-14R to open the *Hydrograph* window.
9. Click on the to close the *Hydrograph* window.

4.4 Define Routing (Varying Diverted Flow)

Now to re-run the simulation using a varying diverted flow:

1. Use the **Select diversion** tool to select the diversion label D1.
2. Select *OC Hydrograph* | **Edit Parameters…** to open the *Edit Orange County Unit Hydrograph Parameters* dialog.
3. Click **Diversion Data…** to open the *HEC-1 Diversion Data* dialog.

4. To define the inflow portion of a rating curve for flow into concentration point 1-14C, select **Define DI** to open the *XY Series Editor*.
5. On the first row enter “0.0”.
6. On each succeeding row increment the value by 50.0 so that the value on the last row is “950.0”.
7. Select **OK** to close the *XY Series Editor*.
8. Select **OK** to close the *HEC-1 Diversion Data* dialog.
9. Select **Done** to close the *Edit Orange County Unit Hydrograph Parameters* dialog.
10. Select *Hydrographs* **| Delete All**.
11. Follow the steps in Section 4.3 to run the simulation again and view the results.

5 Convex Routing

The next example makes use of convex routing

5.1 Open Unit Hydrograph File

Start with opening a new project.

1. Select *File* **| New** .
2. Select **Don’t Save** if prompted to save changes to the project.
3. Switch to the **Hydrologic Modeling Module** . Make sure that “OC Hydrograph” is selected from the *Models* window.
4. Select *OC Hydrograph* **| Open HEC-1 File…** to bring up an *Open* dialog.
5. Locate the file “OCHMConvex.hc1” in the data files for this tutorial.
6. Click **Open** to import the project.

The project contains a simple example using a single concentration point and basin.

5.2 Define Routing

Now to define the convex routing parameters:

1. Use the **Select outlet** tool to select the concentration point labeled 1C.
2. Select *OC Hydrograph* **| Edit Parameters…** to open the *Edit Orange County Unit Hydrograph Parameters* dialog.
3. Click **Routing Data…** to open the *HEC-1 Routing Data* dialog.
4. Change *Routing type* to “Convex (RV)”.
5. Enter a *L* value of “3000”.
6. Enter a *S* value of “0.005”.
7. Enter a *N* value of “0.015”.
8. Enter a *WD* value of “10”.
9. Select **OK** to close the *HEC-1 Routing Data* dialog.

10. Select **Done** to close the *Edit Orange County Unit Hydrograph Parameters* dialog.

5.3 Run the Simulation

Now to run the simulation:

1. Select *OC Hydrograph* **| Run Simulation…** to open the *HEC-1 Run Options* dialog.
2. Click the **browse** button next to *Input File* to open the *Select HEC-1 Input File* dialog.
3. For the *File name* enter “OCHMConvexRoute” and click **Save**.
4. Verify that *Save file before run* is turned on.
5. Select **OK** to start the *Model Wrapper* dialog.
6. When the simulation has finished running, select **Close** to exit the *Model Wrapper* dialog.
7. Select one of the two hydrograph icons displayed at the concentration point labeled 1C.
8. Hold the *Shift* key down and double-click on the other hydrograph icon.

Figure 3 shows the inflow and the routed outflow hydrographs.

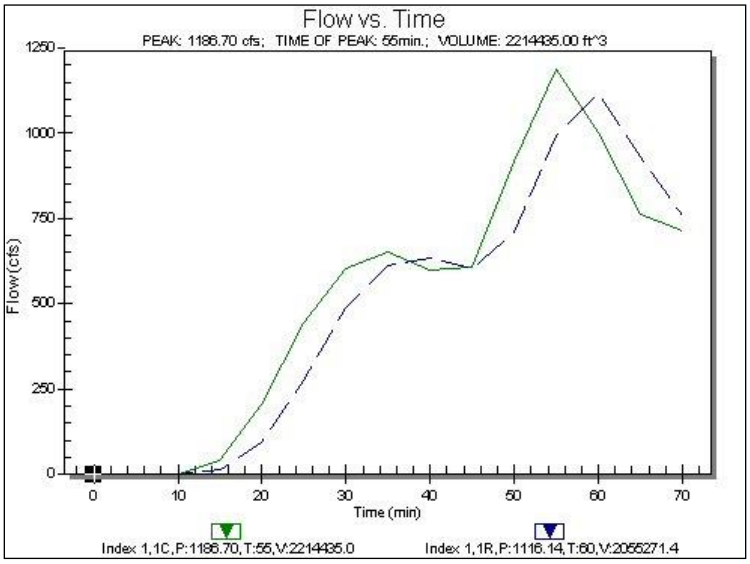

Figure 3 Inflow and routed outflow hydrographs for convex routing

9. Click on the to close the *Hydrograph* window.

6 Conclusion

This concludes the “Orange County Unit Hydrograph” tutorial. This tutorial demonstrated the steps necessary to create a unit hydrograph analysis.